भारतीय मानक

विमान नियंत्रण के लिए पूर्वरूपित इस्पात रस्सियाँ

(दूसरा पुनरीक्षण)

Indian Standard

PREFORMED STEEL WIRE ROPES FOR AIRCRAFT CONTROL

(Second Revision)

ICS 49.035

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

August 2013 **Price Group 5**

Wire Ropes and Wire Products Sectional Committee, MED 10

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Wire Ropes and Wire Products Sectional Committee had been approved by the Mechanical Engineering Division Council.

This standard was first published in 1965 and revised in 1983. Due to changes in rope construction and materials, it was felt necessary to revise this standard. In this revised standard following changes have been made:

a) New rope construction has been added to the standard;
b) New tables based on requirement has been added;
c) Wherever felt necessary tables have been modified;
d) Choice of corrosion resisting steels have been widened; and
e) Certain general provisions are restructured with present practices.

In the formulation of this standard, assistance has been derived from ISO 2020-1 : 1997 'Aerospace — Preformed flexible steel wire rope for aircraft controls — Part 1: Dimensions and loads' and ISO 2020-2 : 1997 'Aerospace — Preformed flexible steel wire rope for aircraft controls — Part 2: Technical specification', Federal Specification MIL-DTI-83420 H and GOST Specification 2172 of 1977.

The composition of the Committee responsible for the formulation of this standard is given in Annex A.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

PREFORMED STEEL WIRE ROPES FOR AIRCRAFT CONTROL

(Second Revision)

1 SCOPE

This standard covers specifications for preformed steel wire ropes of 3 × 7, 7 × 7 and 7 × 19 constructions for aircraft controls.

2 REFERENCES

The standards listed below contain provisions which through their reference in this text constitute provisions of this standard. At the time of publication the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below:

IS No.	*Title*
2363 : 1981	Glossary of terms relating to wire ropes
6528 : 1995	Stainless steel wire — Specification
6594 : 2001	Technical supply conditions for wire ropes and strands

3 TERMINOLOGY

For the purpose of this standard the definitions given in IS 2363 and the following shall apply.

3.1 Nominal Diameter — The value by which the diameter of wire rope is designated.

3.2 Measured (or Actual) Diameter — The diameter which is obtained by measurement as per **5.1** and Annex A of IS 6594, read together with **5.1** of IS 6594.

4 DIMENSIONS, MASS OF ZINC DEPOSITION, TENSILE STRENGTH OF WIRE FOR WIRE ROPES

4.1 Dimensions

The nominal wire diameters necessary for the manufacture of wire rope shall be decided by the rope maker. The tolerances on nominal wire diameters shall be as per Table 1.

Tolerances are same for carbon steel wires as well as for corrosion resistant steel wires.

Nominal diameters of core wires of covering strands or wires of wire strand cores may be of higher diameter than that of nominal wire diameter so as to give a full radial support to the strands.

Table 1 Tolerances on Nominal Wire Diameter

(*Clause* 4.1)

Sl No. (1)	Nominal Wire Diameter (2)	Tolerance (3)
i)	≥ 0.15 to < 0.40	± 0.010
ii)	≥ 0.40 to < 1.00	± 0.015

4.2 Mass of Zinc Deposition on Wires used in Wire Ropes in Case of Carbon Steel Wire Ropes

The minimum values of the mass of zinc deposition on wires when determined as per IS 6745 shall conform to the values specified in Table 2.

Table 2 Minimum Mass of Zinc Deposition for Carbon Steel Wires (After Stranding)

Sl No. (1)	Nominal Wire Diameter mm (2)	Minimum Mass of Zinc Deposition Per Unit Area of Zinc Deposition g/m^2 (3)
i)	$\geq 0.15 - < 0.25$	10
ii)	$\geq 0.25 - < 0.40$	15
iii)	$\geq 0.40 - < 0.50$	30
iv)	$\geq 0.50 - < 0.80$	50

4.3 Tensile Strength of Wires

Tensile strength of individual wires shall be so maintained by the manufacturer that wire ropes made from such wires, satisfy the requirements laid down in this standard.

4.4 Inter Granular Corrosion Bend Test

For corrosion resistant steel wire ropes, wires from the wire ropes shall satisfactorily withstand the inter granular corrosion bend test as detailed below.

The test pieces of wires shall be sensitized by heating to a temperature of 650°C for a period of 45 min followed by cooling in air. All the test pieces then shall be kept immersed for 72 h in a boiling solution having the following composition.

111 g Copper sulphate ($CuSO_4.5H_2O$), 98 g Sulphuric acid (H_2SO_4), relative density 1.84, made up to 1 litre with distilled water.

Precautions shall be taken during the boiling to prevent concentration of the solution due to evaporation.

After this preparation each test piece shall be bent through 90° round a radius equal to three times the diameter or thickness of the test piece, and shall withstand this treatment without cracking on the outer convex surface.

5 MATERIALS

5.1 The chemical composition of steel in case of carbon steel wire rope shall lie within the limits given in Table 3.

Table 3 Chemical Composition (Steel)

Sl No.	Element	Minimum Percent	Maximum Percent
(1)	(2)	(3)	(4)
i)	Carbon	0.5	0.85
ii)	Silicon	—	0.35
iii)	Manganese	0.4	0.90
iv)	Phosphorous	—	0.04
v)	Sulphur	—	0.04

5.2 Corrosion Resisting Steel

The chemical composition of the respective corrosion resisting steel used in case of corrosion resisting steel wire rope shall lie within the limits given in Table 4.

6 MEASURED DIAMETER OF WIRE ROPE

When measured as per **5.1** and Annex A of IS 6594, it shall lie within the values specified in Table 5.

7 CONSTRUCTION OF WIRE ROPES AND LAY LENGTH

7.1 Three types of constructions of wire ropes are covered by this standard are given in Table 6.

7.2 The laying of the wires in strands and that of strands in rope and the lay lengths shall be as per Table 6.

8 GENERAL REQUIREMENTS

The finished wire rope shall be securely laid, free from kinks, loose wires or loose strands or other defects. Wires in the strands shall be uniformly and consistently laid without any overlapping or underlapping. A maximum of one broken wire is permissible on a rope length of 300 m.

8.1 Joints

Joints in wires shall be avoided as far as possible. But, where necessary those shall be as widely apart as possible but in no case more than one wire shall be joined in any length of 10 m of strand.

8.1.1 The joint shall be as far as possible brazed or electrically welded. If the joint is brazed it shall be properly scarfed. If the joint is electrically welded it shall be properly normalized.

9 LAY LENGTH OF WIRE ROPE

9.1 Lay length of wire rope is the distance parallel to the axis of the wire rope in which a strand makes one complete turn around the wire rope's axis.

9.1.1 Measured lay length of respective wire rope shall be as per Table 6.

Table 4 Chemical Composition (Corrosion Resisting Steel)
(*Clause* 5.2)

Sl No.	Element	Corrosion Resisting Steel Percent		Grade X 04 Cr 18 Ni 10 Stainless Steel[1] Percent		Grade X 04 Cr 17 Ni 12 Mo 2 Stainless Steel[1] Percent	
		Min	*Max*	*Min*	*Max*	*Min*	*Max*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	Carbon	—	0.15	—	0.08	—	0.08
ii)	Silicon	—	1.00	—	1.00	—	1.0
iii)	Manganese	—	2.00	—	2.00	—	2.0
iv)	Phosphorous	—	0.045	—	0.045	—	0.045
v)	Sulphur	—	0.03	—	0.03	—	0.03
vi)	Chromium	17.0	20.0	17.0	20.0	16.0	18.5
vii)	Nickel	8.0	12.0	8.0	12.0	10.0	14.0
viii)	Molybdenum	—	—	—	—	2.0	3.0

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[1] Above grades are as per IS 6528.

Table 5 Minimum Breaking Force of Wire Rope

(*Clause* 6, 11, 12 *and* 13)

Sl No.	Nominal Diameter of Wire Rope mm	Construction	Measured Diameter mm		Allowable Increase in Rope Diameter After Cutting mm	Minimum Breaking Force kN		Maximum Mass per 100 m kg
			Min	*Max*		Carbon Steel	Corrosion Resistant Steel	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	0.80	3 × 7	0.80	0.95	0.15	0.49	0.49	0.238
ii)	1.20	7 × 7	1.20	1.40	0.18	1.20	1.20	0.65
iii)	1.60	7 × 7	1.60	1.80	0.24	2.15	2.15	1.15
iv)	1.80	7 × 7	1.80	2.00	0.27	2.63	2.51	1.46
v)	2.00	7 × 7	2.00	2.20	0.30	3.30	3.10	1.80
vi)	2.20	7 × 7	2.20	2.40	0.33	3.77	3.74	2.18
vii)	2.40	7 × 7	2.40	2.60	0.36	4.46	4.10	2.59
viii)	2.50	7 × 7	2.50	2.70	0.38	5.13	4.40	2.81
ix)	4.20	7 × 7	4.20	4.40	0.42	13.65	12.41	7.94
x)	1.60	7 × 19	1.60	1.80	0.24	2.14	2.14	1.08
xi)	2.40	7 × 19	2.40	2.60	0.25	4.45	4.10	2.42
xii)	3.00	7 × 19	3.00	3.20	0.27	6.88	6.44	3.78
xiii)	3.20	7 × 19	3.20	3.40	0.29	8.90	7.85	4.30
xiv)	3.60	7 × 19	3.60	3.80	0.32	9.66	8.52	5.44
xv)	3.80	7 × 19	3.80	4.00	0.34	11.04	9.49	6.06
xvi)	4.00	7 × 19	4.00	4.20	0.36	12.47	10.70	6.72
xvii)	4.50	7 × 19	4.50	4.70	0.41	15.83	13.51	8.51
xviii)	4.60	7 × 19	4.60	4.80	0.41	16.18	14.11	8.89
xix)	4.80	7 × 19	4.80	5.00	0.43	18.71	16.50	9.68
xx)	5.00	7 × 19	5.00	5.20	0.45	19.12	16.68	10.50
xxi)	5.30	7 × 19	5.30	5.50	0.48	21.48	18.73	11.80
xxii)	5.60	7 × 19	5.60	5.80	0.50	24.95	22.28	13.17
xxiii)	6.00	7 × 19	6.00	6.25	0.54	26.36	24.01	15.12
xxiv)	6.10	7 × 19	6.10	6.35	0.55	26.63	24.82	15.63
xxv)	6.35	7 × 19	6.35	6.60	0.57	31.20	28.52	16.12
xxvi)	6.80	7 × 19	6.80	7.00	0.61	33.10	31.60	18.50
xxvii)	7.10	7 × 19	7.10	7.40	0.64	35.64	34.44	20.16
xxviii)	7.20	7 × 19	7.20	7.50	0.65	36.27	35.42	20.74
xxix)	7.90	7 × 19	7.90	8.20	0.71	43.67	42.65	24.96
xxx)	8.00	7 × 19	8.00	8.30	0.72	44.77	43.73	25.60
xxxi)	9.50	7 × 19	9.50	9.90	0.86	64.17	53.48	36.10

10 PREFORMING

10.1 Wire rope shall be preformed.

10.1.1 Preforming may be checked by unlaying two strands opposite to each other for approximately up to two lay lengths and then these two strands are re-laid. On being re-laid wires in the strands and the strands into wire rope shall resume their position.

11 ALLOWABLE INCREASE IN ROPE DIAMETER AFTER CUTTING

When wire rope is cut, there may be an increase in the diameter when measured at the point of cutting. The maximum allowable increase in diameter shall be as stipulated in Table 5.

12 MINIMUM BREAKING FORCE TEST OF WIRE ROPE

Minimum breaking force of respective wire rope when determined as per Annex B of IS 6594 shall be as per Table 5.

13 MAXIMUM MASS OF WIRE ROPE

Maximum mass of respective wire rope shall be as per Table 5.

14 LUBRICATION

14.1 During manufacture a suitable lubricant capable of operating at temperature range between –54°C and + 121°C shall be so applied that each wire of the strand gets coated. If so, explicitly specified by the purchaser, during closing of wire rope additional coat of suitable lubricant be may be applied. Lubricant shall reduce internal friction and inhibit corrosion.

14.2 Lubricant drip and evaporation of lubricant applied during production or during preparation for shipment can be expected. Therefore, in order to ensure optimum performance of wire rope, the user is advised

Table 6 Laying of Wires in Strands and Strand in Rope and the Lay Lengths
(*Clauses* 7.1, 7.2, 9.1.1 *and* 15.2)

Sl No. (1)	**Requirement** (2)	**3 × 7 Construction** (3)	**7 × 7 Construction** (4)	**7 × 19 Construction** (5)
i)	Total No. of strands in wire rope	3	7	7
ii)	No. of wires in each strand and their laying up	7 (6-1)	7 (6-1)	19 (12/6-1)
iii)	No. of wire strand core	Coreless	1	1
iv)	Direction of laying wires in strands except wire strand core and their lay length	6 wires over core wire shall be laid in left hand direction. The length of lay of 6 wires shall not exceed 70 percent of the lay length of the finished wire rope	6 wires over core wire shall be laid in left hand direction. The length of lay of 6 wires shall not exceed 60 percent of the lay length of the finished wire rope	6 wires over core wire shall be laid in left hand direction 12 wires laid over 6-1 wires shall be laid in left hand direction The length of the lay of 6 wires over core wire shall not exceed 60 percent of the lay length of 12 wires to be laid over it The length of the lay of 12 wires laid over 6-1 wires shall not exceed 50 percent of the lay length of the finished wire rope
v)	Direction of laying of wires in wire strand core and their lay length	Coreless	6 wires over core wire shall be laid in right hand direction. The length of lay of 6 wires shall not exceed 60 percent of the lay length of finished wire rope	6 wires over core wire shall be laid in right hand direction 12 wires over 6-1 wires shall be laid in right hand direction Length of the lay of 6 wires shall not exceed 60 percent of the lay length of 12 wires to be laid over it Length of the lay of 12 wires laid over 6-1 wires, shall not exceed 50 percent of the lay length of the finished wire rope
vi)	Direction of laying of strands in wire rope and lay length of finished wire rope	The 3 strands shall be laid together in right hand direction. The length of lay shall be *Min* 5 to *Max* 7 time's the nominal diameter of wire rope	The 6 outer strands shall be laid around the core in right hand direction. The length of lay shall be *Min* 6 to *Max* 8 times the nominal diameter of wire rope	The 6 outer strands shall be laid around the core in right hand direction. The length of lay shall be *Min* 6 to *Max* 8 times the nominal diameter of wire rope

to re-lubricate the wire rope, if considered necessary during its installation and thereafter at regular periodical intervals throughout its service life. The type of lubricant, method of application of lubricant, frequency shall be included in the appropriate aircraft maintenance manual.

15 ELONGATION TEST

15.1 The test is applicable for wire rope of either 7 × 7 or 7 × 19 construction. It is not applicable for wire rope of 0.80 mm, 3 × 7 construction.

15.2 Wire rope sample when subjected to elongation test in the manner specified hereinafter shall withstand the test satisfactorily.

The samples shall be selected according to **18**.

The selected length shall be sufficient enough to provide an unobstructed minimum test length of 500 mm between the grips of testing machine. The test length shall then be progressively be loaded at the rate of separation of jaws not exceeding 10 mm/min, until 60 percent of the specified minimum breaking force is reached. The force shall be then held for 1 min and released to 5 percent of the specified minimum breaking force.

At this initial force of 5 percent, a gauge length of 250 mm shall be marked or use of any suitable elongation measuring device may be made keeping a distance of minimum 100 mm between cutting edges.

The force shall then be increased progressively and uninterruptedly until it reaches to force equal to 60 percent of the minimum specified breaking force of respective wire rope specified in Table 6 and is then held for 1 min and then elongation is measured.

The value of elongation expressed as a percentage of the original gauge length shall lie within limits specified below:

Wire Rope	*Elongation,* Percent	
	Minimum	Maximum
7 × 7 Construction	0.60	0.95
7 × 19 Construction	0.60	1.00

16 ENDURANCE TEST

16.1 Wire rope sample when subjected to endurance test in the manner specified hereinafter shall withstand the load test satisfactorily after completion of the respective number of reversals as specified in Table 7.

An endurance test shall be carried out on one sample at random from each lot of wire rope except that of wire rope of 0.80 mm 3 × 7 construction on which it is not intended to carryout this test.

The general schematic arrangement of the test apparatus shall conform to Fig. 1 and the respective diameters of the test pulleys as per the respective ratios contained in Table 8 shall be as per Fig. 2.

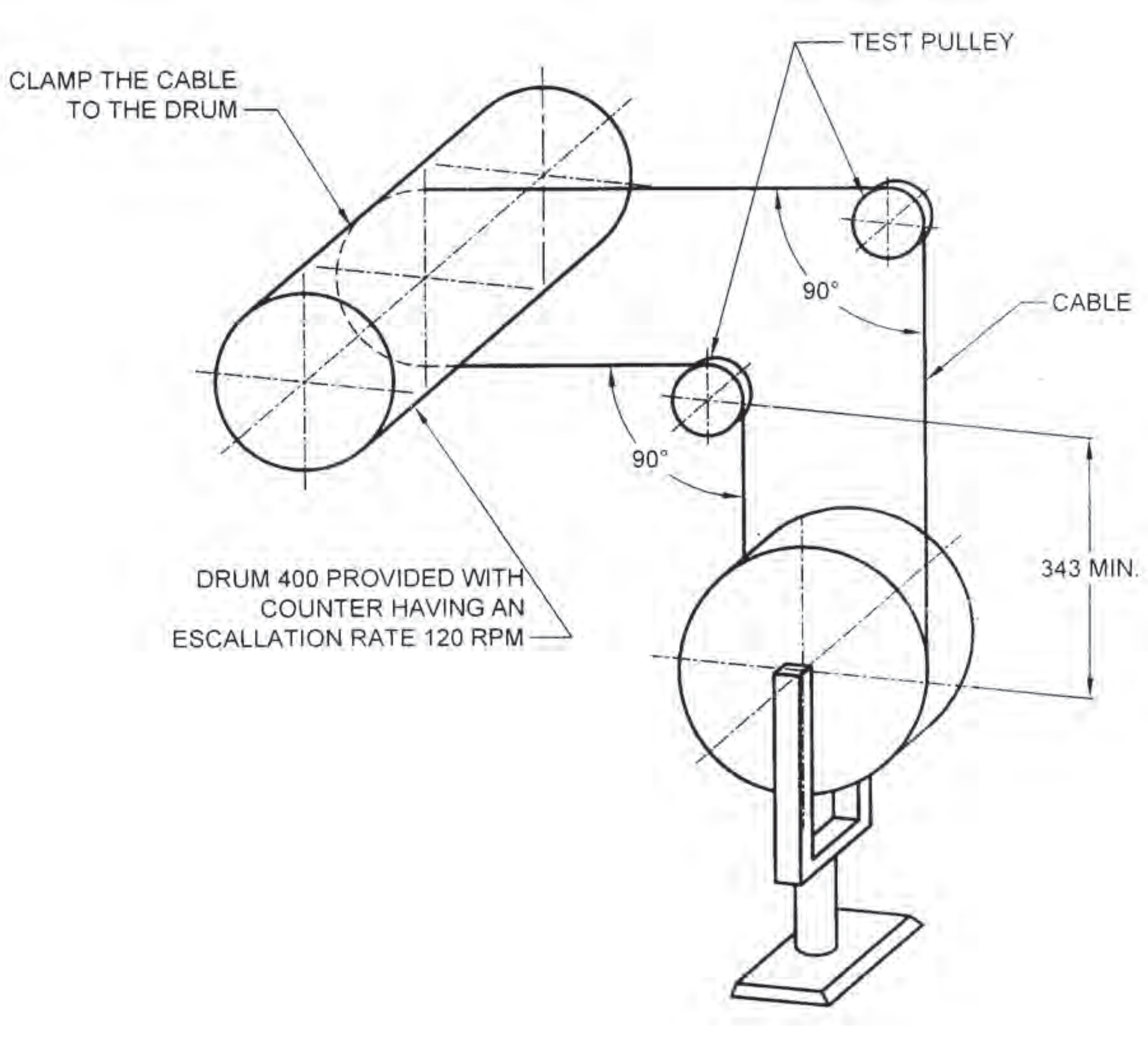
The travel of the test sample of wire rope in one direction shall be minimum 343 mm. The dimensions of the test pulleys for the respective wire ropes shall be as per Table 8.

The test loads are test parameters only and are by no means intended as design criteria. The rate of reversals shall be 120 ± 2 directional reversals per minute and shall be demonstrable by a counter.

Tolerance on Test Pulley Diameters: −0.00 and +0.15 mm.

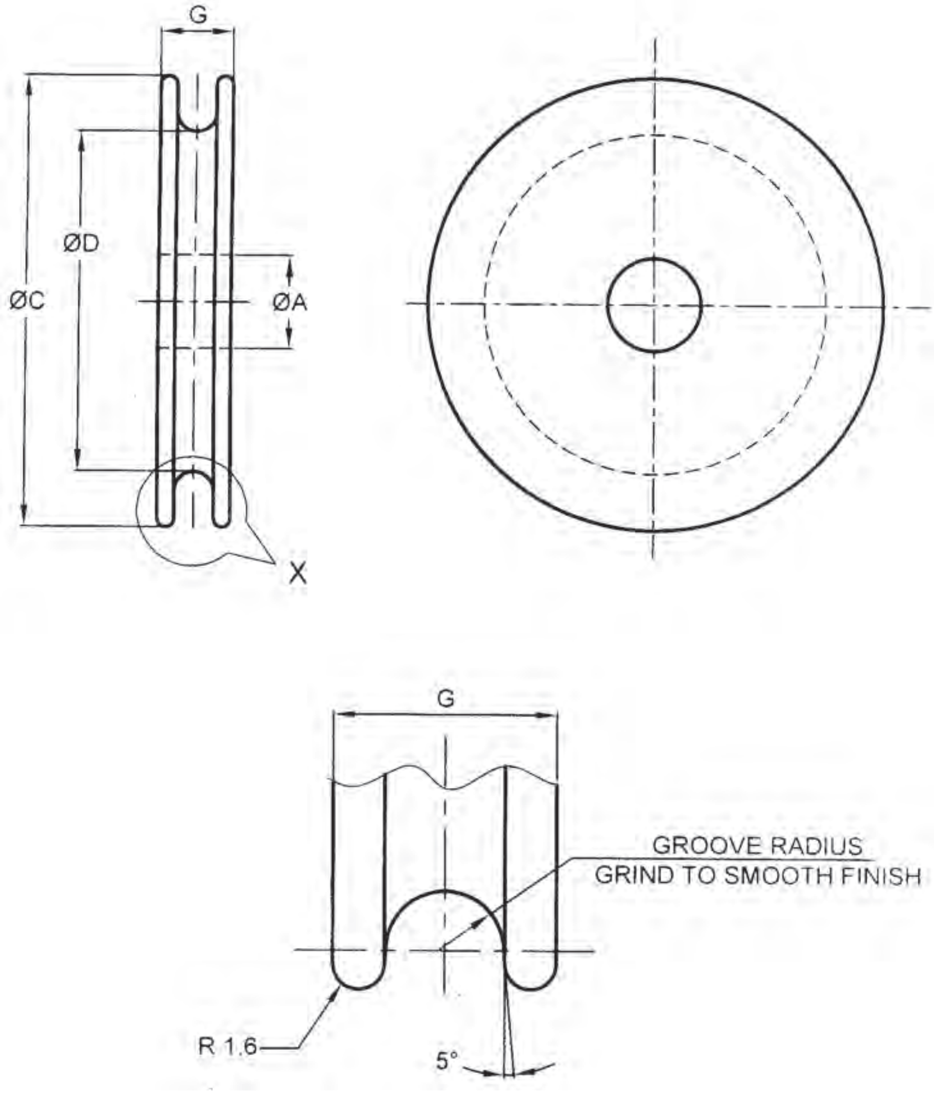
Groove radius, that is, E shall be 55 percent of the nominal diameter of wire rope. The groove radius shall be ground to smooth finish.

Overall collar width, that is, dimension G of the test pulley shall be 10 mm up to and including wire ropes of nominal diameter 4.20 mm, shall be 14 mm for wire ropes of nominal diameter above 4.20 mm up to and


CLAMP THE CABLE TO THE DRUM
TEST PULLEY
90°
CABLE
90°
343 MIN.
DRUM 400 PROVIDED WITH COUNTER HAVING AN ESCALLATION RATE 120 RPM

All dimensions in millimetres.

FIG. 1 APPARATUS FOR ENDURANCE TEST



ENLARGED DETAIL AT X

All dimensions in millimetres.

FIG. 2 PULLEY FOR ENDURANCE TEST

Table 7 Number of Reversals and Minimum Tension Load on Wire Rope

(*Clause* 16.1)

Sl No. (1)	**Size and Construction** (2)	**Number of Reversals for Endurance Test**1) (3)	**Tension Load on Rope Under Test**2) (4)
i)	Wire ropes of nominal dia. 1.20 mm up to and including 2.50 mm in 7 × 7 construction and wire ropes of nominal dia.1 .60 mm upto and including 3.60 mm in 7 × 19 construction	70 000	Minimum 1 percent of the specified minimum breaking force of respective wire rope
ii)	Wire rope of nominal dia. 3.80 mm and above up to and including 9.50 mm dia. in 7 × 19 construction and 4.20 mm in 7 × 7 construction	1 30 000	Minimum 1 percent of the specified minimum breaking strength of respective wire rope

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1) One cycle = 2 Reversals.

2) Test load on wire rope includes one half of the weight of idler pulley and that of the hanger.

Table 8 Dimension of Test Pulleys to be Used During Endurance Test
(*Clause* 16.1)

Sl No. (1)	Nominal Diameter of Wire Rope *d* (2)	Construction (3)	Ratio of Test Pulley Diameter (*C*) to Wire Ropes' Nominal Diameter (*d*) *C/d* (4)	Ratio of Root Diameter of Test Pulley (*D*) to Wire Ropes' Nominal Diameter (*d*) *D/d* (5)
i)	1.20 mm (including) up to and including 2.50 mm	7 × 7	15	12
ii)	4.20 mm	7 × 7	10	7
iii)	1.60 mm	7 × 19	10	7
iv)	2.40 mm	7 × 19	10	7
v)	3.20 mm (including) up to and including 9.50 mm	7 × 19	12.5	9.5

including wire ropes of nominal diameter 5.60 mm and shall be 20 mm for wire ropes of diameter above 5.60 mm. The test pulley shall be made of suitable alloy steel having rockwell hardness of C-60 minimum in hardened and tampered condition. Dimension G is for reference only and not mandatory and is left to manufacturer's discretion.

The dimension A is that corresponding to the pulley support which is on a suitable ball or roller bearing or shaft with extensions supported on suitable ball or roller bearings.

Dimensions of test pulley are test parameters only and by no means intended as design criteria.

Endurance test conditions specified herein may not be conforming to real conditions. The main objective is to ascertain alternating bending fatigue sustainability quality of wire rope. Presently endurance test is to be carried at room temperature only.

Application of lubricant to the endurance test sample in addition to the lubricant applied during the manufacture of wire rope shall not be permitted either before or during the endurance test.

If for any valid reasons test is required to be stopped intermittently, the test may be restarted at the discretion of manufacturer from the last count towards the test.

16.2 After the prescribed numbers of reversals are completed, both the portion of the wire rope under receiving contact on both the test pulleys shall be subjected to post endurance breaking force test. The lower of the two values obtained shall exceed 50 percent of the specified breaking force of respective wire rope in case of carbon steel wire rope and shall exceed 60 percent of the specified minimum breaking force of respective wire rope in the case of corrosion resistant wire rope.

17 SHEAR PROOF TEST

17.1 Wire rope sample when subjected to shear proof test in the manner specified hereinafter shall withstand the shear proof test satisfactorily.

17.2 On the test sample, force shall be uniformly and progressively be applied until it reaches to 80 percent of the minimum specified breaking force for respective wire rope. Exercizing due safety precautions, force shall be held for minimum 5 s. The load then shall be released fully and all the wires of the test piece shall be separated and examined for break. Not a single wire shall be found broken.

18 SAMPLING

18.1 One sample at random shall be drawn out of every 25 000 m or part thereof of the offered lot of each variety of wire rope for each of the tests.

18.2 For inter-granular corrosion bend test, four samples of individual wires shall be selected at random from the wire rope. For mass of zinc deposition test six samples of individual wires shall be selected at random from the wire rope.

19 RE-TEST

If any of the sample is failing in any of the tests, re-test at the request of manufacturer may be carried out taking two test samples representing the same sampling batch. The scope of re-test shall be restricted only to the test in which sample failed. If both the fresh samples withstand the test satisfactorily, the batch shall be deemed to comply with the requirements.

20 MARKING

20.1 A metal label shall be affixed on both the flanges of reel containing following information:

a) Name of the manufacturer;
b) Nominal diameter and construction of wire rope and whether carbon steel or corrosion resistant steel;
c) Production batch No. or Run number;
d) Length of the wire rope; and

e) Any other additional requirement in this regards as specified by the purchaser, to be mentioned on the label.

20.2 BIS Certification Marking

The product may be marked with the Standard Mark.

20.2.1 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act,* 1986 and the Rules and Regulations made thereunder. The details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

21 PACKING

The wire rope supplied shall be wound on a suitable transit worthy wooden or steel reel. The diameter of the reels' barrel shall be minimum 40 times the nominal diameter of wire rope.

The inside of the reels' flange and the barrel of the reel shall be covered with waterproof material before wire rope is wound onto reel. When fully wound, exposed surface of wire rope shall be covered with a layer of waterproof material all along the circumference.

There shall be a minimum ground clearance of 25 mm in case of reels having flange diameter of 300 mm or below, 50 mm in case of reels having flange diameter of 600 mm or below and 75 mm in case of reels having flange diameter above 600 mm. If purchaser requires any special packing, it shall be clearly specified in the enquiry as well as in order.

22 PACKING LENGTHS

The packing lengths shall be as specified by the purchaser.

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

Wire Ropes and Wire Products Sectional Committee, MED 10

Organization	*Representative(s)*
Directorate General of Mines Safety, Dhanbad	Shri G. N. Venkatesh ***(Chairman)***
Amar Promoters Pvt Ltd, Solan	Shri Virender Agarwal Shri Jatinder Agarwal (*Alternate*)
Bharat Coking Coal Ltd, Dhanbad	Shri K. K. S. Sinha Shri U. S. Pandey (*Alternate*)
Bharat Wire Ropes Ltd, Mumbai	Shri D. M. Shah Shri Ashwini Lokhande (*Alternate*)
Central Institute of Mining and Fuel Research, Dhanbad	Shri Awadesh Mahto Shri S. K. Ritolia (*Alternate*)
Directorate of Quality Assurance, New Delhi	Col K. Suresh Col V. V. Kadam (*Alternate*)
Directorate General Factory Advice Service & Lab Institute, Mumbai	Shri G. M. E. K. Raj Shri S. N. Borker (*Alternate*)
Directorate General of Civil Aviation, New Delhi	Shri R. C. Gupta Shri M. M. Kaushal (*Alternate*)
Directorate General of Supplies & Disposals (Quality Assurance Wing), New Delhi	Shri Akhilesh Kumar Shri R. K. Agarwal(*Alternate*)
Directorate. General of Aeronautical Quality Assurance, New Delhi	Shri S. C. Sharma Shri Rishi Kumar (*Alternate*)
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Maccaferri Environmental Solutions (P) Ltd, Pune	Shri Ashish D. Gharpure Shri Mininmol Korulla (*Alternate*)
National Test House, Kolkata	Shri S. P. Roy Shri R. N. Ram (*Alternate*)
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Paradip Port Trust, Paradip	Shri B. B. Panigrahi Shri Mohan Patel Khetra (*Alternate*)
South Eastern Coalfields Ltd, Bilaspur	Shri S. K. Mishra Shri G. Ramaswami (*Alternate*)
Tata Steel Ltd, Dhanbad	Shri Soumendu K. Majhi Shri A. K. Sil (*Alternate*)
The Shipping Corporation of India Ltd, Mumbai	Shri G. S. Bhalla Capt R. Modi (*Alternate*)
The Singareni Collieries Co Ltd, Kothagudem	Shri I V N Prasada Rao Shri P. V. Raghava Raju (*Alternate*)
Usha Breco Ltd, Distt Ghaziabad	Shri Rajesh Prasad Shri Manoj Panwar (*Alternate*)
Usha Martin Industries Ltd, Ranchi	Shri Subrata Dutta Shri S. B. N. Sharma (*Alternate*)

Organization	*Representative(s)*
Vidarbha Hardware Industries, Akola	Shri Om Prakash Dalmia Shri Sanjay O. Dalmia (*Alternate*)
BIS Directorate General	Shri C. K. Veda, Scientist. 'F' and Head (MED) [Representing Director General (*Ex-officio*)]

Member Secretary
Shri D. K. Das
Scientist 'E' (MED), BIS

Bureau of Indian Standards

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